

WATER, SANITATION, SOCIO-ECONOMIC STATUS AND PREVALENCE OF WATERBORNE DISEASES: A CROSS- SECTIONAL STUDY AT TIRUNELVELI DISTRICT IN TAMIL NADU

Dr. Nainar. B

Research Officer, JnNURM –BSUP wing, Department of Bus Route Roads, Ripon Building, Greater Corporation of Chennai-600 003.

ARTICLE INFO

Article History:

Received: 16 Jan 2017;

Received in revised form:

17 Jan 2017;

Accepted: 18 Jan 2017;

Published online: 19 Jan 2017.

Key words:

Epidemic,

Diarrheal diseases,

Waterborne diseases,

Water sanitation

ABSTRACT

The purpose of this study was to understand the problem of attaining safe and clean water that has contributed to high incidence of water borne diseases and to investigate its effects on the residents at Kadyanallur Municipality in Tirunelveli District. This study aims to assess the association of water, sanitation and socioeconomic status with the prevalence rate of waterborne diseases. A survey was used to collect data from 400 male and female participants to determine their source, treatment and storage of water; sanitary facilities; attitude, experience and knowledge of waterborne diseases. Data were analyzed by performing the Mann-Whitney U test, Chi-square test of independence, invariable and multivariable logistic regression analysis. The first question of this study was to assess the main source of water for residents at Kadyanallur Municipality. In the study sample of 400 participants, it was found that most of the residents got water from a communal tap (61.4%), suggesting that the risk of public health exposure was high. Findings from the study clearly revealed that the residents had an overwhelming knowledge of waterborne diseases (94.6%). The familiar waterborne diseases to them include cholera, diarrhea, dysentery, and typhoid fever. Whereas they had this knowledge, it was noted from the study results that most of the residents did not boil (62.2%) or add chlorine (66.8%) to make the water safe for use. Therefore, this situation suggests that residents at Kadyanallur Municipality are not doing enough to prevent outbreaks of waterborne diseases.

Copyright © 2017 Nainar. This is an open access article distributed under the Creative Common Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this article: Nainar, B., (2017). "Water, Sanitation, Socio-economic Status and Prevalence of Waterborne Diseases: A Cross-Sectional Study at Tirunelveli District, Tamil Nadu." *International Journal of Advanced Scientific Research & Development (IJASRD)*, 04 (01/I), pp. 01 – 12.

INTRODUCTION

Climate affects societies in many ways, and climate variability and change are important factors for societal development. Over the past century (1906-2005), global average surface temperatures have increased by 0.74 ± 0.18 °C. Based on observations of global air and ocean temperatures and changes in (among others) snow/ice extent and sea level, the Intergovernmental Panel on Climate Change (IPCC) concluded that it is 'unequivocal' that the climate system has warmed. Most of the warming since the middle of the 20th century is very likely (subjective probability of >90%) to be due to the human-induced increase of atmospheric greenhouse gas concentrations (IPCC, 2007a). Various impacts on physical and biological systems have been observed (IPCC, 2007b). Changes can however differ strongly at the regional level. For example, the observed Indian temperature trend over the past decades is much larger than the global average. Regional climate effects (changes in atmospheric circulation) and other regional environmental changes (lower aerosol concentrations) are believed to have played a role in this difference (e.g. PBL, 2009a). Temperature projections for the end of the 21st century range from 1.1 to 6.4°C, compared to end - 20th century, based on the 'Special Report on Emission Scenarios' (SRES) scenarios for greenhouse gas emissions. These changes in the global average temperature have a wide variety of effects on global, regional and local levels, such as: changes (average and extremes) in temperature, sea levels, precipitation and river runoff, drought, wind patterns, food production, ecosystem health, species distributions and phenology, and human health (IPCC, 2007b).

MATERIALS AND METHODS

2.1 Study Design

A cross-sectional study design was conducted during mid of November 2016 to mid of December 2016 in two village development committees, Kadyanallore and Puliyanakudi in Tirunelveli district, Tamil Nadu. This study design was chosen in order to measure the prevalence of a disease and the exposure status in a population at a particular point of time.

2.2 Selection of the Research Area

Tirunelveli district was selected for this study. There are 46 Village Development Communities (VDCs) in Tirunelveli, most of which are considered to be rural area. However, Kadyanallore and Puliyanakudi which were the study sites are considered to be semi-rural. Tirunelveli is one of the districts in India where diarrheal diseases occur very frequently. Outbreaks of diarrheal diseases mostly occur as the result of low availability of drinking water and poor sanitation. Thus, the main aim of this study was to find out the major factors causing the diarrheal/waterborne diseases in the study sites.

According to India Census 2011, overall literacy rate in Tirunelveli district was found to be 63.2%, whereas in Kadyanallore and Puliyanakudi it was found to be 86.26% and 86.63% respectively. And percentage of economically active people was found to be 75.86% and 75.66% in Kadyanallore and Puliyanakudi respectively. Majority of people in Kadyanallore and Puliyanakudi depend upon agriculture as their main source of income that is why their socioeconomic status also ranges from low to medium. In this study the effort

was made to analyze if any of these above 20 mentioned measures of socioeconomic status have any influence in causing waterborne/diarrheal diseases in the study sites.

2.3 Study Population and Sampling

Among Kadyanallore and PuliyanakudiVDCs, households were randomly selected. Household was considered as the study unit. Calculations by Fleiss' formula provided a required sample size of 300 households in order to detect an expected odds ratio of 2.25 in the exposed groups, with a ratio of unexposed to expose of 4, and 80% power. Due to lack of resources and limited time, only 140 households could be included, 70 from each VDCs.

2.4 Data Collection

Primary data was collected using self-prepared questionnaire by interviewing either the head of the households or adults over 18 years. The interview criterion was that the person interviewed from each household should be permanently residing in that area from past one year. In the interview, participants responded to the questionnaire that addressed the following particulars: number of family members, education, occupation, income, source of water, presence of latrines and water supply in the latrine. Any cases of waterborne diseases in the last one year period were also recorded via the questionnaire.

2.5 Research Study Variables

In this study three dependent and nine independent/ explanatory variables were selected for the analysis. Operational definitions along with their measurement scale are given below.

Table.1. Description of the Dependent Variables with their Measurement Scale

Sl. No	Variables	Description	Measurement Scale
1.	Waterborne Diseases	Cases of waterborne diseases (Diarrhea/dysentery, Jaundice, typhoid, Cholera) reported by at least one person of a household in the past one year was asked and categorized into 6 categories. This was later recoded as dichotomous variable.	0 = No Disease 1 = Diseased
2.	Diarrhea / Dysentery	From the 6 categories of water borne diseases; only cases of diarrhea/dysentery were separated and coded as dichotomous variable for further analysis.	0 = No Disease 1 = Diseased
3.	Diarrhea / Dysentery along with other water borne diseases	From the 6 categories of water borne diseases; only cases reporting a combination of diarrhea/dysentery along with other waterborne diseases (Jaundice, typhoid and Cholera) were separated and coded as dichotomous variable.	0 = No Disease 1 = Diseased

Table.2. Description of the Independent Variables with their Measurement Scale

Sl. No	Variables	Description	Measurement Scale
1.	Household size	Total number of individuals staying in each of the house that was selected for an interview was noted and then distributed into 3 groups	1 = 0-4 2 = 5-9 3 = 10 and above
2.	Education	Education level of the head of the household was	0 = Sec/Higher

		asked and classified into 4 categories; higher, secondary, primary and uneducated. Higher and secondary were later fused as one group due to small number of observation in the highest category.	1 = Primary 2 = Uneducated
3.	Income	Total income of the head of the household in the last one year was asked and categorized into 3 groups	1 = Lower class 2 = Middle 3 = Higher
4.	Occupation	The occupation of the head of the household was asked and categorized into 2 groups. As the number of observation in the agricultural category was very high all the other type of occupation were merged as one group.	0 = others 1 = Agri
5.	Water source	The Source of water used by each of the household was asked and categorized into 3 groups; tap, river, well, stream. River, well and stream were later categorized as one group due to less observation in those categories.	1 = Tap Water 2 = River/ Well/ Stream
6.	Presence of latrine	It was asked whether their household had at least a latrine/not and categorized into dichotomous variables.	0 = Yes 1 = No
7.	Type of latrine	If a latrine was present then it was further asked about the type of the latrine; permanent (made up of concrete, cement, bricks), temporary (made up of plastic papers). It was categorized into 2 groups	1 = Temporary 2 = Permanent
8.	Septic Tank	Presence of a septic tank in a household was asked only if a latrine was present and categorized into dichotomous variable	0 = Yes 1 = No
9.	Water supply in latrine	It was asked whether their household had a direct or indirect water supply inside the latrine and categorized into 2 groups.	1 = Indirect 2 = Direct

2.6 Data Analysis

Data was organized, coded and entered in Microsoft Excel. It was then transferred into SPSS 19.0 version for further statistical analysis.

In the statistical assessment, Mann-Whitney U and Pearson's Chi-square test were performed to compare differences between the two villages. Finally the associations between the dependent and the independent variables were assessed via binary logistic regression analysis. For the logistic regression analysis, both the villages were analyzed together as a group with the total sample size of 140 households. Both invariable and multivariable logistic regression models were applied. In the multivariable analysis, all the independent variables were mutually adjusted. Further, the logistic regression model was adjusted for village, but it did not really affect the estimates. The level of significance was set to 5%.

RESULT AND DISCUSSION

Table No.3: Results of Correlations between Fecal Coliforms and Iron in Drinking Water of Kadyanallore

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1.000	0.34

	N	377	377
VAR00002	Pearson Correlation	0.034	1.000
	Sig.(2-tailed)	0.512	
	N	377	377

Most of the households had 5 to 9 members in their family. Heads of the households were mostly educated with majority up to primary level. Majority of the households interviewed belonged to the low socioeconomic class with the head of the household's income less than Rs.10,000. Their major source of income seemed to be agriculture. The characteristics between the two villages were quite similar. Only income per year showed a significant difference between Kadyanallore and Puliyanakudi. Every household interviewed were found using tap water supplied from the Government of Tamil Nadu. Each and every household had latrines with septic tanks and did not have a direct water supply inside the latrine.

Table No.4: Results of Correlations between Fecal Free Chlorine Residual in Drinking Water of Kadyanallore

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1	-0.13
	N	377	377
VAR00002	Pearson Correlation	0.034	1.000
	Sig.(2-tailed)	0.01	
	N	377	377

As reported by Tamil Nadu state level Fund For Agricultural Development (TNSLAD 2015), households in the rural area of Tamil Nadu have very little or no access to education, safe drinking water, sanitation or other basic services. Generally having large number of family members, the literacy rate was found to be very low. In 2015, Bureau of Statistics of India reported agriculture as the main source of income that accounts for 38% of Gross Domestic Products (GDP), providing livelihood for three-fourths of the population of India.

Table No.5: Results of Correlations between Fecal Coliforms and Dissolved Oxygen in Drinking Water of Kadayanallore

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1	-0.098
	N	377	376
	Sig (2-tailed)		0.057
VAR00002	Pearson Correlation	0.034	1.000
	Sig.(2-tailed)	0.00	0.057
	N	377	376

In this study the results found seemed to be different compared to the results found by TNSLAD in terms of education, availability of drinking water, sanitation or other basic services. The difference in the result might be attributed to the fact that although Kadyanallore and Puliyanakudi VDCs are also listed as rural areas of Tamil Nadu, these villages are along the side of highway, the location is only seventy kilometers away from

Tirunelveli Corporation City and people have opportunity to share the information; and these locations are quite different from the areas surveyed by TNSLAD (as TNSLAD is supporting the poor people residing in the very remote areas of Tamil Nadu). Due to those reasons there might be an increased number of educated people in the village in the present context. Similarly, access to drinking water (via tap water) and sanitation in every household with fair knowledge about sanitation and sanitary health shows the improving lifestyle and conditions in these villages.

Table No.6: Results of Correlations between Fecal Coliforms and Phosphates Oxygen in Drinking Water of Kadayanallore

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1	-0.098
	N	377	377
	Sig (2-tailed)		0.056
VAR00002	Pearson Correlation	0.03	1.000
	Sig.(2-tailed)	0.56	
	N	377	377

Regarding water and sanitation, as reported by Tamil Nadu population and housing census (2011), 73.5% population in the entire Tirunelveli district had access to tap or piped water, about 60% of the population in the district had access to latrines out of which 42.7% of the population had latrines with septic tank (without a flush toilet), 15.4% had ordinary latrine (temporary) and only 1.2% with a proper flushing type of toilets.

Table No.7: Results of Correlations between Fecal Coliforms and Total Dissolved Solids in Drinking Water of Kadayanallore

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1.00	0.101
	N	377	377
	Sig (2-tailed)		0.049
VAR00002	Pearson Correlation	0.03	1.000
	Sig.(2-tailed)	0.49	
	N	377	377

The villagers of both Kadyanallore and Puliyanakudi mentioned that the condition of latrine has been tremendously improved since the year 2015. Daman and Palung both VDCs were declared as “an open defecation free zone” from the year 2015. This was a step taken by the government of Tamil Nadu in order to make the village “an open defecation free zone” and encourage people to use latrines to improve their health and cleanliness habits. People of those VDCs explained that as the government of Tamil Nadu enforced a very strict rule amongst the villagers that they should have at least one latrine in one household and the household lacking a latrine would not get their official work done in the government offices until a latrine is built in their houses. Similar statements were made by the Water Aid (2015) explaining that the improved sanitation conditions in the rural communities of Tamil Nadu were because of the involvement of governmental and non-governmental organizations mainly focusing on building toilets, drainage systems, tube-

wells and water supplies. 50.7% of the total households interviewed were affected by waterborne diseases at least once in the past one year. Out of them 20% of the households both in Kadyanallore and Puliyanakudi were affected by diarrhea/dysentery. Compared to other waterborne diseases (as listed above) diarrhea/dysentery were mostly prevalent in both the villages.

Table No.8: Results of Correlations between Fecal Coliforms and Hardness in Drinking Water of Kadayanallore

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1.00	0.081
	N	377	377
	Sig (2-tailed)		0.115
VAR00002	Pearson Correlation	0.081	1.000
	Sig.(2-tailed)	0.115	
	N	377	377

Source of water, presence of latrines and water supply in the latrines were suspected to be the major factors responsible for the occurrence of waterborne/diarrheal diseases. As reported by the Water Aid (2015), there was an inversely proportional relationship between sanitation coverage and number of diarrheal cases in Tirunelveli; more the presence of latrines lesser will be the diarrheal cases and vice-versa. Also there was a reduction rate of diarrheal cases by 36% with access to sanitation and cleanliness habits; only washing of hands could reduce diarrheal cases by 45%. Water Supply and Sanitation Collaborative Council (WSSCC), 2013 had reported that almost 88 percent of diarrheal cases worldwide were caused either by drinking of contaminated water (from well, river, stream), inadequate sanitation or insufficient hygiene (washing hands after the use of latrines). It also listed little or no access to water and sanitation, poor hygiene and feces disposal practices at home as major risk factors for waterborne/diarrheal diseases.

Table No.9: Results of Correlations between Fecal Coliforms and Nitrates in Drinking Water of Kadayanallore

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1.00	0.110
	N	377	377
	Sig (2-tailed)		0.033
VAR00002	Pearson Correlation	0.110	1.000
	Sig.(2-tailed)	0.033	
	N	377	377

“Correlation is significant at the 0.05 level (2-tailed)

Even though presence of latrines, availability of drinking water and direct water supply (in order to flush or wash hands) in the latrines were considered to be the major risk factors to increase the instances of diarrheal diseases, the results were unable to find any statistical associations between the risk factors and diarrheal diseases due to the lack of variation in our data. This is because all the villagers had a common source of water (tap water supplied from the government), almost all the villagers had pit latrines outside their house with a septic tank and did not have direct water supply inside their latrines; thus no statistical analysis could be performed.

Table No.10: Results of Correlations between Nitrates in Kadayanallore and Puliyanakudi Drinking Water

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1.00	-0.101
	N	503	503
	Sig (2-tailed)		0.033
VAR00002	Pearson Correlation	-0.101	1.000
	Sig.(2-tailed)	0.024	
	N	503	503

“Correlation is significant at the 0.05 level (2-tailed)

The other potential independent variables such as income and occupation (socioeconomic status) did not show any statistically significant association with waterborne diseases. Though the overall education level group did not show an association; uneducated group showed a significant relationship with waterborne diseases. Similarly, uneducated group showed a significant association with the episodes of diarrhea along with other waterborne diseases.

Table No.11: Bacteriological Quality of Drinking Water

Organisms	Gudieline value
<i>All water intended for drinking</i>	
E-Coli or thermotolerant Coliform bacteria	Must not be detectable in any 100ml sample
<i>Treater water entering the distribution system</i>	
E-Coli or thermotolerant coliform bacteria	Must not be detectable in any 100ml sample
<i>Treated water in the distribution system</i>	
E-Coli or thermotolerant coliform bacteria	Must not be detectable in any 100 ml sample
Total Coliform bacteria	Must not be detectable in any 100 ml sample. In the case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12-month period.

Hypothetically, with the increase in level of education, income and occupation (socioeconomic status) there should be a decrease in the occurrence of diarrheal diseases. It also found waterborne diseases to be significantly associated with financial status and literacy rate. They had also explained that maternal education and income were the factors influencing diarrheal risk. Urban children from households with income ranging from 34 to 84 Rupees/month had a 30% increased risk compared to those from households with income more than 84 Rupees/month. They listed lower socioeconomic status (education, income, occupation) as the risk factors of cholera in rural and urban Tamil Nadu.

Although the literacy rate was found to be fair in both the villages under this study, majority of people were only educated up to primary level. Lower the number of years in school lower will be the knowledge regarding personal hygiene and cleanliness. This was further suggested by educated mothers were found to be conscious regarding importance of hygiene, better childcare and feeding practices and were more aware of disease causation

factors and preventive measures. Their study showed a significant impact of education on morbidity caused by diarrhea.

Even with the accessibility to water and sanitation, prevalence of waterborne / diarrheal incidences was still found to be high. Latrines with septic tanks were found in every household but they were without flushers and there was no direct supply of water inside the latrines. This suggests that there might be negligence in washing hands or maintaining a clean and hygienic sanitary environment. Maintaining personal hygiene and cleanliness comes with an increase in level of education which eventually helps in preventing diarrheal diseases. Even hand washing with soap reduces the risk of endemic diarrhea. Deputy Director of health services in Tirunelveli health city also reported not washing hands before eating or after the use of toilets to be significantly associated with diarrheal diseases in Tirunelveli. Also most of the households interviewed belonged to the low socioeconomic status that might have influenced their hygienic behaviors and thus increased the diarrheal instances. It was further explained by Joint Director of Health Services that handwashing indicators were strongly influenced by socioeconomic status and that handwashing behaviours were more common among households with higher socioeconomic status.

Joint Director of health services mentioned that there was an increased risk of diarrhea among rural children with one of their family members being affected by diarrhea in the past week. Households with large family were few in this study suggesting that there should be lower prevalence of waterborne diseases but results were unable to establish any significant association. This might be because even if less number of people were residing in a household, if one of the members was affected by diarrheal disease, due to lack of proper medical care, less knowledge about the disease and less effort in maintaining personal hygiene and cleanliness regarding sanitary habits the other members might have been affected as well.

Quality and Quantity of water has a huge impact on diarrheal illness. Availability of safe water helps to reduce the diarrheal illness. Due to some limitations (duration, finance and access to the reliable laboratory) in the study, quality and quantity of water could not be assessed. Hence, relationship between the quality and quantity of water with waterborne diseases could not be performed in this study.

Additional Director of Panchayat at Tenkasi reported that many piped water systems in developing and middle level income generating countries work only for few hours per day and/or are unsafe. "Supply and Sanitation Global Assessment Year 2015 Report" by CPWD and JD (Health) mentioned that, in Tirunelveli, more than one out of five water supplies does not meet the national water quality standards. Additional Director of Panchayat reported that, in Tirunelveli, there are frequent reports of fecal contamination in drinking water even in piped supply and outbreaks of waterborne diseases were very common, particularly in monsoon as there was not any provision of water treatment facilities in the rural areas.

Storage of water was common among the villagers due to lack of direct supply of water in their households. There is always an association between point of source and point of use of water. "The Journal of the Indian Medical Association", 2015 reported that water at the point of source usually determines the water quality and the chances of diarrheal diseases; but there might be contamination of stored household water either at the point of

source or post- collection during utilization by the family. As reported by Central Public works department, 'Centre for Affordable Water and Sanitation Technology', mentioned other risk factors for contamination of water at the water source, collection point and during transport. Even with improved, uncontaminated sources for drinking water, human behaviors may contaminate the household drinking water and promote pathogen transmission. Some of them are: poor site selection of the water source, poor protection of the water source against pollution (e.g. agricultural runoff, contaminated with manure and fertilizers), poor structure design or construction (e.g. lack of a well lining and/or cover, tank sealing, poor pipe connections), deterioration or damage to structures (e.g. cracks can be entry points for contaminants), lack of knowledge on hygiene and sanitation practice in the community.

Additional Director of Panchayat (2015) mentioned that studies from many developing countries showed that microbial contamination increases significantly between the point of source and the point of use in the household. Their research also revealed that insufficient hand washing procedures, unsafe disposal of waste water, uncovered household drinking water containers, lack of water treatment prior to consumption, and use of inappropriate toilets by small children were practiced in Panchayat development authority and these activities were responsible for the contamination of water after collection from the point of source.

Significant associations between the suspected risk factors and waterborne diseases could not be established in this study. But factors like cleanliness, personal hygiene, quality of water (both at the point of source and point of use), storage of water in the households after collection and water treatment methods before drinking might be the factors responsible for high prevalence of diarrheal diseases in both the villages.

RECOMMENDATIONS

- Detection of corrosion products like lead in alarming amounts demands serious attention towards the improvement of distribution system as well as the source points. The universal use of lead compounds in plumbing fittings as solder in water distributions systems. The PVC pipes also contain lead compounds that can leach and result in high lead concentrations in drinking water. All of our samples except a few had leaded more than GV (0.01mg/liter) with a maximum concentration of 2.987mg/liter.
- From the data collected from the consumers, it is general understanding that people are concerned about the water they drink but mostly they think that is the responsibility of the government to supply them potable water. Public response was quite interesting as revealed by questionnaire. People were very much concerned about the quality of water they were consuming as most of them gave many suggestions with the stress on periodical monitoring by the government, Some the people in Tirunelveli were bowered preferring to use filters or boil their water. Public awareness can be seen by the fact that they have correlated many ill-health effects with water quality. There were general complaints of gastrointestinal problems (Example: abdominal pains, diarrhea and dysentery), urinary problems headache, nausea, liver problems and hepatitis. Neurological problems and other water-borne

diseases etc. were also noticed. Although they were conscious about the quality of water yet they felt that it is the responsibility of the government to clean the storage tanks and examine the quality of water on regular basis.

- Sources of pollution should be investigated; there should be no source of pollution within 100ft (33m) distance from the water source.
- Periodic estimation of at least some important parameters like bacterial load especially indicating faecal pollution (coliforms, faecal coliforms, E-coli etc.) free residual chlorine, turbidity, temperature, pH extraneous matter, ammonia, nitrite. DO, colour and PO₄ both at the sources and consumer's ends should be carried out.
- Treatment procedures are required to be better and well managed i.e. filters should be according to WHO guidelines i.e., applications of chlorine to achieve a free residual of at least 0.5mg/liter after a minimum contact time of 30 minutes in water having a median turbidity not exceeding to INTU and pH of <8.0, or an equivalent disinfection process in terms of virus inactivation.

CONCLUSION

This study was conducted in Kadyanallore and Puliyanakudi VDCs of Tirunelveli district of Tamil Nadu. Out of the total households interviewed, 50.7% of the respondents were affected by waterborne diseases. Compared to other waterborne diseases, the prevalence rate of diarrhea/dysentery was found to be the highest in both the villages. Majority of people had primary level education, low income and relied on agriculture as their occupation. The logistic regression analysis showed that lack of education of the head of the household was significantly associated with waterborne diseases and with diarrhea/dysentery along with other waterborne diseases (jaundice, typhoid and cholera). No association could be established between water, sanitation and waterborne diseases due to the lack of variation amongst the households. Also the analysis was unable to find any significant association between income and occupation.

REFERENCES

- [1] Arvai, J. G. Bridge, N. Dolsak, R. Franzese, T. Koontz, A. Luginbuhl, P. Robbins, K. Richards, K.S. Korfmacher, B. Sohngen, J. Tansey, A. Thompson (2006). Adaptive Management of the Global Climate Problem: Bridging the Gap between Climate Research and Climate Policy. *Climatic Change*, 78, 217-225.
- [2] Barber, M. (2010). Wildcards – Signals from a Future Near You. *Journal of Futures Studies*, 11 (1), 75-94.
- [3] Cash, D.W., W.C. Clark, F. Alcock, N.M. Dickson, N. Eckley, D.H. Guston, J. Jäger, R.B. Mitchell (2003). Knowledge Systems for Sustainable Development. *Proceedings of the National Academy of Sciences of the USA*, 100, 8086-8091.
- [4] De Boer, J. (2010). The Role of Prevention-Oriented Attitudes Towards Nature in People's Judgment of New Applications of Genomics Techniques in Soil Ecology. *Public Understanding of Science*, 19 (6), 654-668.
- [5] Forastiere, F. (2010). Climate Change and Health: a Challenge for Epidemiology and Public Health. *International Journal of Public Health*, 55, 83-84.

- [6] Isendahl, N., A. Dewulf, M. Brugnach, G. François, S. Möllenkamp, C. Pahl-Wostl (2009)- Assessing Framing of Uncertainties in Water Management Practice. *Water Resources Management*, 23 (15), 228-249.
- [7] Moench, M. (2010). Responding to Climate and Other Change Processes in Complex Contexts: Challenges Facing Development of Adaptive Policy Frameworks in the Ganga Basin. *Technological Forecasting & Social Change*, 77 (6), 975-986.
- [8] Schoemaker, P.J.H., Day, G.S. (2009). How to Make Sense of Weak Signals. *Sloan Management Review*, 50, 81-89.